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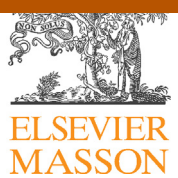

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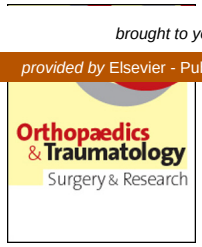

ORIGINAL ARTICLE

Distal quadricepsplasty in children: 88 cases of retractile fibrosis following intramuscular injections treated in Benin

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KEYWORDS
Retractile fibrosis of the quadriceps;
Plasty;
Child;
Quadriceps contracture

Summary
Introduction: Retractile fibrosis of the quadriceps (RFQ) is a physical and social handicap in children, and often results from a past history of quadriceps intramuscular injection. The aim of this study was to evaluate the therapeutic results of RFQ treated by distal quadricepsplasty using a modified Thompson-Payr procedure (DQPMTP).
Hypothesis: Functional recovery will be good with DQPMTP.
Patients and methods: This is a descriptive retrospective 10-year study from 2002 to 2011, including 74 children (88 knees) less than 15 years old, admitted for RFQ and treated in Benin. The types of RFQ were: knee flexion loss of motion 16 cases (18.2%), lag of extension 54 cases (61.4%) and associated genu recurvatum, 18 cases (20.5%). Wasting of the thigh was found in all cases. An associated distal femoral osteotomy was performed to correct a bone deformity in 18 cases (20.5%).
Results: There were 16 cases (18.2%) of poorly looking postoperative scars and 2 cases (2.3%) of fracture during physical therapy. Mean flexion ROM after surgery was 77.7°. Mean flexion increased from 77.7° to 108.5° following postoperative rehabilitation or a mean gain of 30.7°. The quadriceps muscle testing scores were at least 3/5. Results of DQPMTP were good in 80.7% of cases, as shown by mean active knee flexion of 108.5° with normal active extension. The results were satisfactory in 17 cases (19.3%).
Discussion: DQPMTP has the advantage of cutting a minimum of blood vessels, thus limiting the risk of hematoma. Laterally placed incisions create less tension reducing the risk of skin necrosis. The clinical and radiological results of this series confirm those in the literature. Treatment of RFQ by DQPMTP provides satisfactory functional rehabilitation in patients, which confirms our hypothesis.
Level of evidence: Level IV, retrospective study without comparison.

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Introduction

In the 1960s, intraquadricipital (IQ) injections were an alternative to intragluteal injections, in particular in newborns, especially premature infants and young babies whose buttocks muscles were not yet developed, to avoid post-injection sciatic nerve palsy [1]. However, very quickly several studies in the developed countries described a disorder of the extensor apparatus of the knee called retractile fibrosis of the quadriceps (RFQ). With the increased use of the intravenous route, complications became rare [2—5]. An estimated 26% of the sequella from quinine salt injections resulted in FRQ in the study by Onimus et al. [6]. Management is based on treatment that is well known to practitioners. Our goal was to evaluate the therapeutic results of distal quadricepsplasty according to a modified Thompson-Payr procedure (DQPMTP) and compare this experience in Benin with other existing treatment choices.

Patients And methods

Type of study

This descriptive retrospective 10-year study was performed from January 1, 2011 to December 31, 2011, at the Centre Hospitalier Départemental ZOU/COLLINES and the Hôpital de la Mère et de l'Enfant Lagune (HOMEL).

Means, ranges and standard deviations were used to describe quantitative variables. The Pearson or Yates Ch^{i2} tests and the Fisher test were used to compare proportions of qualitative variables. $P < 0.05$ was considered to be significant.

Patients

Inclusion criteria

Our study population included 74 children (88 knees) both girls and boys, 15 years old or less, with RFQ due to an intramuscular injection treated by distal quadricepsplasty according to a modified Thompson-Payr procedure (DQPMTP) and postoperative functional rehabilitation. Patients with isolated fibrosis of the rectus femoris or mixed RFQ that was not treated surgically or by a surgical method other than DQPMTP were excluded.

Patient's clinical features

Fourteen of the 74 patients included in this study had bilateral RFQ, 35 had right RFQ and 25 left RFQ. Knee stiffness in extension was frequent, and found in 54 cases (61.4%) with a range of motion between −10° and +10°. There were 18 cases (20.4%) of genu recurvatum and 16 cases (18.2%) of flexion stiffness with a range of motion of between 15° and 40°.

Radiological features

Standard X-ray was performed in all patients and showed 13 cases of genu recurvatum of a mean −35° (−70—−15) and 8 cases with an associated mean valgus deformity of 30° (20—45).

The results of preoperative ultrasound and CT scan of the thigh in 2 patients were similar to X-ray results.

Comparative ultrasound of the thighs showed atrophy of the left vastus lateralis with hyperechogenic muscle fibers, and the vastus intermedius with sclerotic and very thin muscle fibers curving around the femur, while these lesions were much less visible in the vastus medialis. The rectus femoris was also atrophied in certain areas.

Comparative CT scan of the thighs showed overall wasting of the different groups of muscles on the injured side, which was more severe in the rectus femoris and the vastus intermedius.

Features of treatment

DQPMTP was combined with a femoral osteotomy in the clinical forms of RFQ in this series with associated femoral deformities. Six of the 18 cases of associated osteotomy involved RFQ in extension with patellar dislocation and a valgus deformity, and 12 cases involved genu recurvatum.

Surgical technique

The DQPMTP was modified by using an anterolateral incision and performing extra-articular plasty of the quadriceps muscle based on lengthening the rectus femoris with a distal musculotendinous flap, instead of the vastus intermedius.

A longitudinal incision was made on the sagittal plane in the form of an inverted ''h'' on the left thigh and the letter ''h'' on the right thigh, beginning on the lateral side of the middle third of the thigh and stopping across from the lateral femoral condyle circling the patella and ending across from the medial femoral condyle. The rectus femoris muscle was mobilized and isolated from the other vastus muscles: its distal tendon was then cut. A rectangular shaped musculotendinous flap no longer than 1/3 the length of the thigh was cut from the distal vastus intermedius. Incisions with the electric scalpel were made circling the patella and cutting the lateral and medial retinacula at the femoral condyles. The tensor fasciae latae was cut. The flap from the vastus intermedius was transferred above the periosteum towards the knee to avoid injuring the suprapatellar bursa. At this stage the knee was mobile. Repeated flexion and extension was performed until maximum flexion was obtained. Lengthening reconstruction was performed by suturing the tendon of the rectus femoris to the distal flap of the vastus intermedius with the knee in 45°—60° flexion and sometimes more. The vastus lateralis and the vastus medius were then sutured along the edge of the new muscle created by the reconstruction. The incision was closed on two planes (Fig. 1). The patient was placed in a thigh-to-foot cast with the knee in 45°—60° flexion for 4 weeks, which is long enough for the incision to heal. A window was opened in the cast to dress the wound after 8—10 days.

A flexion osteotomy of the femur was performed and stabilized with pins in knees with a genu recurvatum deformity.

When the knee was stiff in extension associated with a valgus deformity, a varus osteotomy was performed and stabilized with pins.

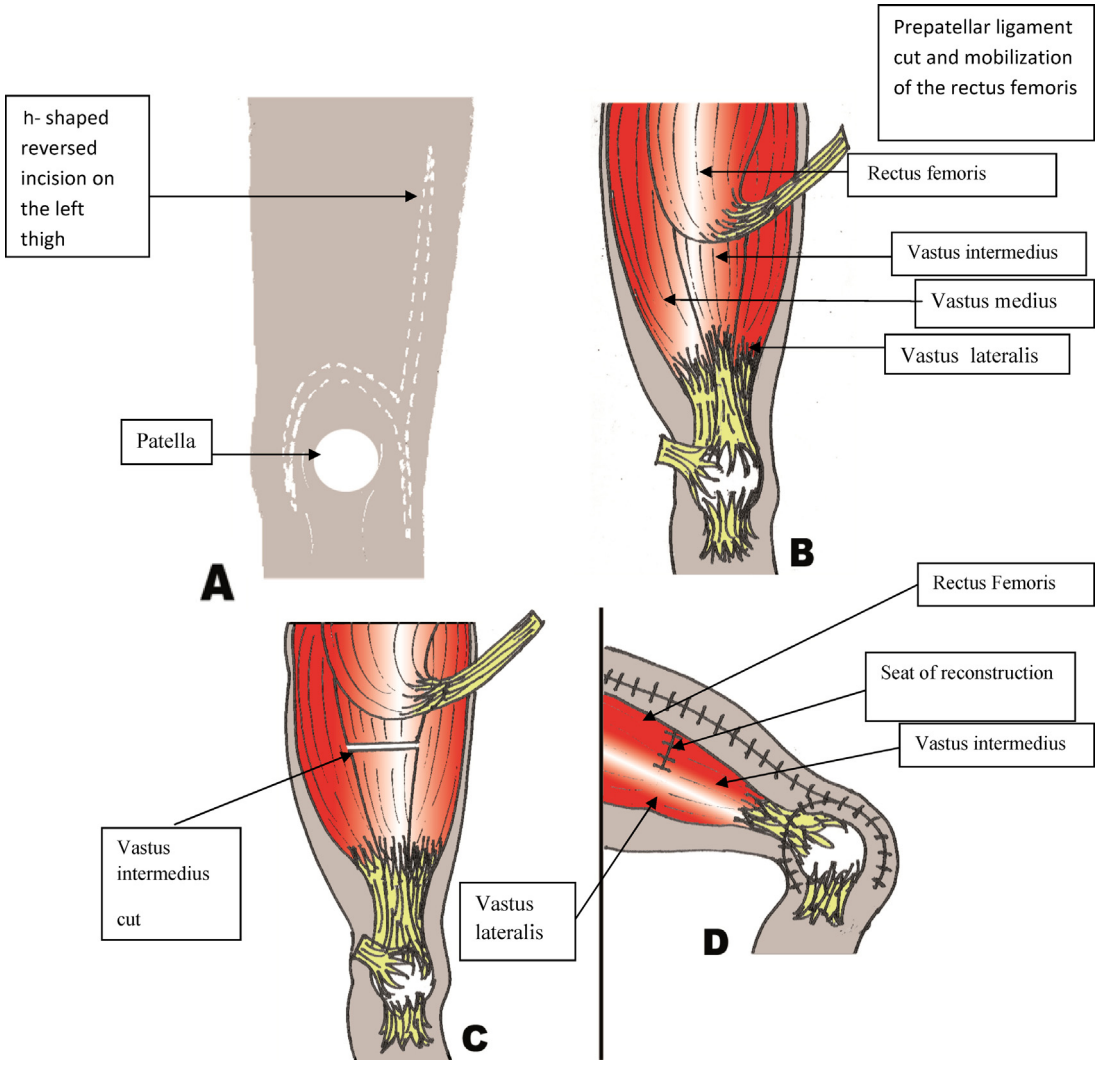

Figure 1 Technique of Distal quadricepsplasty according to a modified Thompson-Payr method (DQPTPM). A. h-shaped reversed incision on the left thigh. B. Section of the tendon and release of the Rectus femoris in its groove. C. Preparation of the musculotendinous flap by the vastus intermedius cut. D. Reconstruction of the rectus femoris with the musculotendinous flap and skin closure with the knee in flexion.

Evaluation of therapeutic results

Clinical results of treatment were evaluated in the children who underwent a follow-up after a mean 5 years (1—9), based on muscle tests and the Mukherjee criteria.

Postoperative tests of the quadriceps were performed by having patients who were seated, with the leg hanging free perform resisted knee extension.

The results of the Mukherjee [7] criteria are considered to be good if the flexion is above 90°, which allows squatting and normal walking. The results are satisfactory if flexion is between 45° and 90° with normal walking and comfortable sitting. The results are poor if flexion is less than 45° associated with limping and discomfort when sitting.

A radiological assessment was performed for this study. This included 2 patients who underwent preoperative ultrasound and CT scan and 2 others 4 years after surgery.

Results

Evaluation of postoperative flexion

Flexion immediately after surgery, as well as following surgery and functional physical therapy are reported in Table 1. Mean flexion immediately after surgery was 76.5°(35—122). Mean flexion after functional rehabilitation was 108.5° (80—131). The difference was statistically significative ($P = 10^{-8}$).

Complications

Early postoperative complications included 6 cases (6.8%) of skin necrosis and 2 cases (2.3%) of hemorrhage of the surgical incision site.

Table 1 Distribution of cases by immediate postoperative flexion and after DQTMPT and functional rehabilitation.

Forms (*n*)	Immediate flexion	Final acquired flexion	%
Flexion (*n* = 16)	93° (76—122)	117.4° (109—130)	18.2
Extension (*n* = 54)	72.2° (50—110)	99.4° (80—131)	61.4
Recurvatum (*n* = 18)	68.1° (35—95)	108.7° (82.5—120.5)	20.5
Mean ± SD (min—max)	76.5° ± 18.7 (35—122)	108.5° ± 15.5 (80—131)	

SD: standard deviation; min: minimum value; max: maximum value; $P = 10^{-8}$.

Late complications included 16 unattractive scars including 6 cases (6.8%) of hypertrophy and 10 cases (11.4%) of hypotrophy.

During functional rehabilitation, 2 cases (2.3%) of femoral fracture were reported.

One case (1.1%) of muscular hypotonia was observed with slight laxity of the medial retinaculum resulting in patellar subluxation.

Clinical evaluation of the results

Table 2 reports the postoperative results of muscle testing in the 88 knees after 1—9 years of follow-up. The results of muscle tests were at least 3/5 in all cases. Results of 3—4 were found in 18 patients with genu recurvatum and 13 with flexion stiffness.

The results were good according to the Mukherjee score in 71 cases (80.7%) and satisfactory in 17 cases (19.3%).

Radiological assessment

A comparative ultrasound and CT scan of the thigh were performed in 2 of the surgical patients to evaluate the postoperative results of the quadriceps muscle after reconstruction. The results of both imaging tests were similar. On ultrasound, the structure of the muscles was normal, pennated like a leaf or feather on both sides, showing that the fibrotic process had stopped: nevertheless, the distal portion of the left vastus intermedius seemed to disappear.

On CT scan, there was still wasting in the operated thigh. By reconstructing slices from top to bottom, we could see that the muscular bundles of the vastus intermedius gradually thinned until they disappeared completely at the distal third of the thigh so that the quadriceps which initially had 4 heads now presented as a ''triceps''.

Table 2 Post-treatment muscle test score according to the type of RFQ.

Test	(3—4) *n* (%)	5 *n* (%)	Total
Stiffness			
Flexion	4 (4.5)	12 (13.6)	16
Extension	10 (11.4)	44 (50.0)	54
Recurvatum	17 (19.3)	1 (1.1)	18
Total	31 (35.2)	57 (64.8)	88

n = number of cases.

Discussion

Therapeutic results

Surgical treatment is recommended when muscular fibrosis is clearly established [8]. In this study, the mean increase in flexion after quadricepsplasty and functional rehabilitation was 108.5° after a mean 5 years of follow-up.

Sengupta [9] has suggested performing proximal quadricepsplasty in the early stages of knee stiffness, before any morphological changes have occurred in the knee. He published 14 cases of RFQ with a mean postoperative increase in flexion of 65° at 2 years of follow-up. Although there were cases of RFQ with no morphological change in the knee in our study we did not perform the proximal reconstruction recommended by this author. In a study by Hnevkovsky [10], 12 children received this treatment, resulting in a final acquired flexion of approximately 90°. This mean postoperative flexion was, in fact, better than the results by Burnei et al. [11] in 2 different groups using the Judet (85°) and Thompson-Payr (78°) techniques.

Burnei et al. [11] did not find any significant difference in the increase in flexion between the Judet (85°) and Thompson-Payr (78°) techniques. Muteti et al. [12] obtained a final gain in flexion of 94.7° using the Thompson-Payr quadriceps tendon lengthening technique with additional resection of the fibrous area.

Physical rehabilitation significantly improves flexion in operated knees [13]. In our series, it resulted in an increase in flexion from 77.8° to 108.5° or a mean gain of 30.7°. The youngest subjects recovered the best, which supports the results of Mukherjee et al. [7].

Postoperative complications

The rate of postoperative skin necrosis (6.8%) was less than in the studies by Mukherjee et al. [7] and Burnéi et al. [11] (12.8%). Dehiscence of the surgical incision can be explained by the tightening of the median surgical incision when the knee is flexed. There is less risk of this complication with lateral incisions [14]. The use of the modified lateral incision in our series, which provides a better view of the distal quadriceps due to a longer semicircular incision above the 2 femoral condyles, prevents nerve, blood vessel and periosteal injury. Because all of the surgical manoeuvres of DQPMTP were extra-articular, we could be sure that the synovial recesses and articular surfaces were intact. This was not true in the series by Muteti et al. [12] who opened the knee in case of patellar dislocation, creating

permanent postoperative patellar instability. Burnéi et al. [11] reported hematomas in 1.1% and Onimus et al. [6] in 18.8%. Unlike other techniques, DQPMTP has the advantage of cutting as few blood vessels as possible, thus limiting the risk of hematoma. Nevertheless immediate postoperative hemorrhage occurred in 2.3% of the cases in our series.

Soumah et al. [15] reported that the Thompson-Payr technique limits the postoperative adhesions that often develop during highly invasive operations of the muscles in children.

Evaluation

Clinical evaluation

The muscle tests scores in more than half the cases (59.1%) were at least 3/5. After a mean postoperative follow-up of 5 years DQPMTP resulted in test scores of 3/5 at worst. One of the reasons that Onimus et al. [6] prefer the Judet technique to DQPMTP is weakening of the quadriceps, with a risk of limited active extension, which was reported in 70% of the cases by Jackson et al. [16]. In our experience, this risk seemed to be minimal with DQPMTP.

We feel that release of the vastus intermedius up to its origin (Judet) and Z or V lengthening of the quadriceps tendon (Thompson-Payr) causes elongation, which explains the insufficient extension described in the long term results by these authors [6]. Postoperative rehabilitation also improves muscle strength and mass [13].

Results were good in 80.7% of the DQPMTP as shown by a mean active knee flexion of 108.5° and normal active extension. This rate is better than that obtained by Soumah et al. [15] (56.5%) and Jackson et al. [16] (57.5%). Our results were similar to the 83.8% good and excellent results reported by Hung [17]. Unlike this author, we did not have any poor results.

Radiological results

Postoperative ultrasound and CT scan images showed that the quadriceps muscle, which has 4 heads, only had 3 heads at the distal third of the thigh that was operated on. Indeed by suturing the distal bundles of the vastus intermedius that were cut mid-thigh, with the proximal tendinous portion of the rectus femoris, a single muscle head was created in the distal third of the thigh. This suggests that the four heads of the quadriceps are reduced to three heads by DQPMTP without loss of function. This may be because the vastus intermedius and the rectus femoris are on the same anatomical plane and ensure complementary knee extension functions, thus favoring the implementation of this treatment option.

Despite our good results with DQPMTP, we feel that it is also important to emphasize the importance of preventing RFQ.

Prevention of RFQ

Awareness must be raised on the importance of systematically using oral, rectal or intravenous routes of administration. Thus, like Burnéi et al. [11] in the developed countries, a consensus must be reached both on the prevention of RFQ and on the treatment of severe cases.

For this reason, we feel that the intramuscular quadriceps injection of drugs, and especially of quinine should be forbidden in children [16,18].

Conclusion

We performed an update on the different available treatments to manage the complex entity RFQ. A modified Thompson-Payr technique followed by functional rehabilitation improved results in our series with good results in 80.7%. Based on this success rate compared to other techniques, we recommend DQPMTP for the correction of RFQ. Nevertheless, preventive measures must be taken to avoid new cases of RFQ.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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